



PCT/GL 33 / 0-0 4-0



INVESTOR IN PEOPLE

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH RULE 17.1(a) OR (b)

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 06 NOV 2003	
WIPO	PCT

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 21 October 2003

BEST AVAILABLE COPY



The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference	8714 GB/DTD	17SEP02 E748629-2 D00001 P01/7700 0.00-0221451.8
2. Patent application number (The Patent Office will fill in this part)	16 SEP 2002	0221451.8
3. Full name, address and postcode of the or of each applicant (underline all surnames)	MOLECULAR OXYGEN LIMITED Mill End Thaxted Essex CM6 2LT	
08465635001 Patents ADP number (if you know it)		
If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom	
4. Title of the invention	Gas Generator	
5. Name of your agent (if you have one)	Abel & Imray	
"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)	20 Red Lion Street London WC1R 4PQ United Kingdom	
Patents ADP number (if you know it)	174001	
6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it) Date of filing (day / month / year)
7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing (day / month / year)
8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body. See note (d))	Yes	

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form

Description

7

Claim(s)

2

Abstract

1

Drawing(s)

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

1

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11.

I/We request the grant of a patent on the basis of this application.

Signature

Abel & Imray

Date

Abel & Imray

16.09.02

12. Name and daytime telephone number of person to contact in the United Kingdom

David T. Darby - 020 7405 0203

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.

GAS GENERATOR

This invention relates to gas generators, more
5 especially oxygen generators, and in particular to a
generator for providing breathable oxygen.

Breathable oxygen generation by a chemical reaction has
been known for a very long time, and portable oxygen candles
are articles of commerce. A typical candle comprises an
10 oxygen-containing chemical, for example an alkali metal
chlorate or perchlorate, in admixture with a catalyst that
facilitates lower temperature decomposition of the chemical
to oxygen and residual solids and optionally a fuel, for
example iron. A typical catalyst is manganese dioxide, which
15 reduces the temperature at which potassium chlorate
decomposes from about 400°C to below about 240°C.

However, the overall reaction is exothermic, and the
exterior of the reaction mass generally reaches very high
temperatures, of the order of 600°C or more. Considerable
20 efforts have been made to provide portable devices that can
safely be held by the user during operation despite the high
temperatures reached during the reaction.

A number of thermally insulated devices are described in
U.S. Patent No. 5 725 834 (Nishii et al, assigned to Daicel
25 Chemical Industries, Ltd.). The patent describes a prior art
device in which silica is used as thermal insulation, which
has the dual function of maintaining the exterior of the
housing at an acceptably low temperature and maintaining the
interior of the candle at a high enough temperature to ensure
30 decomposition of all contained materials, to maximize oxygen
output. In one embodiment of the Nishii invention itself, a
cylindrical candle is surrounded by porous solid insulation
within a copper jacket which is separated by an annular air
space from the housing. The oxygen generated passes through

the insulation to an outlet of the device at the head of the cylinder. In other embodiments there are more coaxial airspaces and the generated oxygen traces a convoluted passage through them, ensuring that it is cooled before
5 reaching the user, and that the outer surface of the housing does not get too hot. All these measures, while being effective, inevitably add bulk and weight to the device.

There accordingly remains a need for an insulated gas generator the thermal insulation of which may result in
10 apparatus that is lighter and less bulky than existing apparatus.

The present invention provides a chemical gas generator comprising a generating device producing gas by chemical reaction, the device being at least partly enclosed within
15 thermal insulating means comprising a vacuum jacket.

Advantageously, the gas generated is oxygen, and for simplicity will be referred to as such in much of the discussion below. The invention is, however, applicable to generators of other gases.

20 The generator is typically generally in the form of a cylinder, referred to hereinafter as a candle. The candle may be a cast body or a loose-filled or compacted powder, pelletized, or granular material. The candle advantageously comprises a metal chlorate or perchlorate, preferably an
25 alkali metal, especially sodium or lithium, chlorate or perchlorate, in admixture with a catalyst, especially manganese dioxide, and a metal, especially iron or magnesium. The candle is provided with ignition means, which may be electrically powered or operated by percussion cap or
30 chemical reaction. The ignition means may be at one end of the candle or centrally located to provide two burn fronts travelling in different directions, preferably opposite directions towards the ends of the candle. The invention

accordingly also provides an oxygen generator in which the generating device comprises:

(a) generating means for chemically generating oxygen when ignited and

5 (b) ignition means for igniting the generating means, the generating means being arranged to sustain during operation propagation of a plurality of, preferably two, burn fronts therethrough, the fronts propagating in generally different, preferably opposite, directions, the device being
10 at least partly enclosed within thermal insulating means comprising a vacuum jacket.

A burn front is the interface region bounded by unburnt and burnt regions of the generating means, and in operation travels towards the unburnt region.

15 The provision of the ignition means at a central region of the candle has the advantage that the ignition site, which becomes the hottest part of the candle, is remote from reusable parts of the generator, e.g., electrical circuitry if electric ignition is used. Further, the use of two or more
20 burn fronts dissipates the heat generated over a wider area and assists in the control of the burn process.

The oxygen generating means may, for example, comprise at least one first element positioned and arranged for ignition by the igniting means, and a plurality of second
25 elements each positioned and arranged for ignition by a first element, so that in operation a plurality of burn fronts is propagated through the at least one first element and through the plurality of second elements, the direction of propagation of one of the burn fronts differing from the
30 direction of propagation of at least one other of the burn fronts.

The ignition means may, for example, be located in the central region of an oxygen generator of a generally cylindrical shape, the length of the generator being greater

than its diameter so that in operation two burn fronts are propagated from the central region toward opposite ends of the generator. In this case also, there are preferably provided at least one first element of the generating means
5 arranged for ignition by the ignition means and a plurality of second elements for ignition by a first element. There may be a succession of elements extending toward one or preferably both ends of the generator, each arranged for ignition by the immediately preceding element.

10 Whether the ignition means is at one end or centrally located, elements adjacent to and closer to the ignition means are advantageously more reactive than elements more remote from it, to improve stability of the candle and render it less susceptible to accidental ignition. Step-wise
15 gradation of the elements facilitates manufacture, as each element has a uniform composition, and the candle is then assembled from discrete components. The interfaces between elements may be of conical or frusto-conical form, assisting in control of burn front propagation between adjacent
20 elements.

The ignition means may be, for example, an electrically resistive heating device, a percussion cap detonator or a cartridge ignition device, or an exothermic chemical reaction, initiated, for example, by causing or allowing
25 contact between previously separated reagents. If desired, the candle may include more than one type of ignition device. Electrically resistive heating devices are preferred, being intrinsically safe until energized.

Preferably, the ignition means comprises a resistive
30 heating device, and the generator further comprises electronic control means for controlling electrical power applied to the heating device to initiate combustion. Use of electronic control means enables an improved degree of ignition control to be achieved. The control means

preferably includes coupling means for inductively coupling electrical power from the control means to the heating device; such inductive coupling is of benefit in that exposed electrical contacts may be avoided in the generator, such contacts being susceptible to oxidation and being potentially unreliable.

To conserve battery power and yet ensure reliable ignition of the generating means, the control means may include timing means for automatically controlling the period during which electrical power is applied to the heating device for initiating combustion.

When electrical or electronic ignition is employed, the control means advantageously includes at least one, preferably more than one, battery providing power for the ignition means to initiate oxygen generation, the control means further comprising battery monitoring means for monitoring remaining power deliverable from the at least one battery. The monitoring means indicates to a user the status of the battery needs.

The monitoring means advantageously includes a light emitting diode indicator and/or a liquid crystal display indicator for indicating remaining power deliverable from the battery or batteries. Light emitting diode indicators are more visible in subdued lighting, for example at dusk or night-time, whereas liquid crystal display indicators are more visible in strong illumination, for example in bright sunlight.

More details of a gas generator having these features are given in International Patent Application No. PCT/GB02/02603.

The candle is advantageously provided with an apertured, for example perforated, casing, for example, of gauze, of a material, preferably a metal, of high thermal conductivity, for example copper or brass, in good thermal contact with the

candle material. The casing transmits heat from the burn front and the burnt region to the unburnt region or regions, thereby pre-heating the unburnt region and help establish an even burn. The perforations provide channels for the oxygen to flow.

An intermediate layer or layers of insulation may be provided between the candle or the casing if present and the vacuum jacket. This insulation may be rigid or flexible, for example, of ceramic, rockwool, or particulate material.

10 The candle is at least partially contained within a vacuum-jacket vessel. The vessel is advantageously of complementary shape to the candle, or to the casing if present, clearance being provided between the internal wall of the vessel and the peripheral wall of the candle to allow oxygen to reach the outlet, a spacer or spacers being provided to secure the position of the candle within the vessel. The spacer or spacers may be shaped to provide a tortuous path for the oxygen to follow to allow some cooling before reaching the outlet of the generator.

20 The vacuum-jacket vessel may be of any material capable of withstanding the temperatures reached by the burning candle; a steel, preferably stainless steel, vessel is presently preferred. Alternatively, a robust glass vessel, for example, a borosilicate glass vessel may be used.

25 A spacing between inner and outer walls of the vessel in the range of from 3 to 5 mm is presently preferred. The vessel is evacuated to provide a high vacuum, advantageously in the range of from 10^{-7} to 10^{-5} mbar (0.01 to 10 Pa), for example about 10^{-6} mbar (0.1 Pa).

30 The generator according to the invention may be provided with means to blend the oxygen produced with atmospheric air, to deliver oxygen-enriched air, rather than pure oxygen, to a user. The generator may also be provided with a chlorine absorbent to absorb any traces of chlorine generated with the

oxygen; the copper or brass used as a casing may perform this function also, or additional copper or brass for example, in particulate form, may be provided in the oxygen pathway.

5 The following Example illustrates the invention.

An oxygen generator constructed in accordance with the invention comprises a sodium chlorate-based candle encased in a copper gauze and delivering 90 litres of USP oxygen at a rate of 6 litres per minute.

10 The encased candle had a length of 12 cm and a diameter of 3.5 cm, and was encapsulated in insulation material and then in a vacuum flask of length 17 cm, internal diameter 6 cm and external diameter 7 cm. The generator weighed 0.6 kg and had a total length of 17 cm. In operation, the
15 highest temperature reached at the exterior of the flask was 50°C.

For comparison, a generator commercially available from Molecular Products Limited and containing an identical candle
20 was tested. The candle was insulated by rockwool and ceramic material. The total weight of the generator was 0.5 kg, its length was 13 cm and its diameter 10 cm. In operation, the highest exterior temperature reached was 150°C.

CLAIMS:

1. A chemical gas generator comprising a generating device producing gas by chemical reaction, the device being at least
5 partly enclosed within thermal insulating means comprising a vacuum jacket.

2. A generator as claimed in claim 1, which generates oxygen.

10

3. A generator as claimed in claim 2, wherein the device comprises a metal chlorate or perchlorate, in admixture with a catalyst and optionally a fuel.

15 4. A generator as claimed in claim 3, wherein the device comprises sodium chlorate, manganese dioxide, and iron.

5. A generator as claimed in any of claims 1 to 4, wherein the device comprises electrically powered ignition means.

20

6. A generator as claimed in claim 5, wherein the ignition means is located in a central region of the device.

7. A generator as claimed in claim 6, wherein the
25 generating means is arranged to sustain during operation propagation of a plurality of burn fronts therethrough, the fronts propagating in generally different directions.

8. A generator as claimed in claim 7, wherein in operation
30 there are two burn fronts travelling in opposite directions.

9. A generator as claimed in any of claims 1 to 8, wherein the device is provided with an apertured casing of a material of good thermal conductivity.

10. A generator as claimed in claim 9, wherein the casing is of metal gauze.

5 11. A generator as claimed in any of claims 1 to 10, wherein the vacuum jacket vessel is of stainless steel.

12. A generator as claimed in any one of claims 1 to 11, wherein the pressure in the interior of the jacket is in the
10 range of from 10^{-7} to 10^{-5} mbar.

13. A gas generator as claimed in claim 1 and substantially as described in the Example.

GAS GENERATOR

ABSTRACT

5

A gas generator insulated by a vacuum jacket vessel.

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☒ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.